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WOOD CONTENT OF STACKED 4-FOOT ROUND PULPWOOD IN CONNECTICUT

by

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Wood Content Of Stacked 4-foot Round Pulpwood In Connecticut[1/]

Applicable To Plantation-grown Pine And To Mixed Hardwoods

by

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Buying wood stacked in 4-foot lengths is sometimes like buying a pig in a poke. A cord is simply a pile 4 by 4 by 8 feet, or 128 cubic feet. Even though wood piled this way may stack up to the specified dimensions, the actual amount of wood in the pile may vary greatly. The species, the size of the sticks, the thickness of the bark, the crookedness of the sticks, and the presence of protruding knots all have a bearing on the amount of solid wood that a pile contains. While one pile may be packed tightly, another may be full of big air holes. In this study, the factor most affecting the solid content appeared to be the method of piling the wood. If the stacks were put up haphazardly the solid content was usually appreciably lower than for neat, well-stacked piles.

A relatively easy method for measuring the actual wood content of such piles is described in this paper. The results, from a short pilot study made in Connecticut, are applicable to white and red pine pulpwood cut from plantations in Connecticut, and to mixed hardwood pulpwood also cut from stands in that state.

The cubic-foot wood content per standard cord--with bark and without bark--is summarized in table 1. The effect of average stick diameter on solid content is clearly shown in comparing red and white pine. Pulpwood cut from the latter was considerably smaller wood with a rather large number of sticks of 2- and 3-inch diameter (which is usable for roofing fiber but generally too small for pulpwood). Red pine averaged nearly 2 inches larger in diameter and, in most of the piles examined, tended to fall within a narrow range of

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1/ This study was carried out under a cooperative project in farm forestry research sponsored jointly by the Connecticut State Forestry Service, the Connecticut Agricultural Experiment Station, the Connecticut Forest and Park Association, and the Northeastern Forest Experiment Station of the U.S. Forest Service.

Table 1.--Solid content of stacked 4-foot pulpwood in Connecticut

Species	Sticks per cord, average	Average stick diameter outside bark	Solid content of stacked cord	
			With bark	Without bark
Softwoods:	Number	Inches	Cubic feet	Cubic feet
Red pine[1/]	112	6.0	91.8	79.2
White pine	191	4.4	86.4	75.1
Mixed hardwoods:				
Red maple predominant	89	6.5	81.5	71.0
Oaks predominant	92	6.5	93.7	82.2

1/ Includes 2 samples of Scotch pine.

diameters. Uniformity of stick size in any pile generally resulted in closer piling with a resulting increase in solid content.

It has been generally thought that a standard cord of hardwood contains less wood volume than a similar quantity of softwood. The study shows that this is not necessarily true. If the sticks are of good size and fairly straight, the cord of mixed hardwoods may have a wood content equal to that of the plantation-grown pines. The oak pulpwood examined in this study tended to be of better form than the maple and of appreciably larger diameter than the pine. This is why the cords in which oak was the predominant species averaged considerably higher in wood content.

In using these data it may not always be convenient to rick the wood in standard cords. The method used makes it possible to estimate wood content on a percentage basis--regardless of the height and length of the pile. These data are shown in table 2. They should, of course, be used only for wood cut in the 4-foot length. Shorter sticks would have somewhat less taper and therefore would fit together more closely. Longer sticks would tend to bulk up with somewhat larger air spaces.

Table 2.--Percentage of space occupied by solid wood and bark in 4-foot pulpwood ricks

Species	Wood with bark	Wood minus bark	Bark alone
	Percent	Percent	Percent
Softwoods:			
Red pine[1/]	71.7	61.7	10.0
White pine	67.4	58.7	8.7
Mixed hardwoods:			
Red maple predominant	63.6	55.5	8.1
Oaks predominant	73.2	64.1	9.1

1/ Includes 2 samples of Scotch pine.

THE METHOD USED

The wood volumes were estimated from photographs. A dot grid system was employed to determine the ratios of wood, bark, and air space in stacked piles.

The original plan was to locate at random a fairly large number of piles of stacked pulpwood, ricked separately by species if possible. However, all the wood photographed was cut by commercial operators, and it was not possible to get a differentiation among species. In the final tabulation, the total stacked wood was divided into four groups: all red pine, all white pine, mixed hardwood with red maple predominating, and mixed hardwood with oaks predominating. It was considered desirable to photograph only round wood, because splitting introduced an unknown variable in the net cubic content. The piles photographed--24 in all--were not taken entirely at random because of photographic limitations; for example, in some places the camera point could not be located the required distance from the pile.

Photographic Procedure

All photographs were made from a distance of 12 feet, having the line of sight of the camera at right angles to the side of the pile being photographed. This seemed to be the best range. A closer view would not include enough of the side area of the pile for a representative cross section. A longer range would obviously have resulted in a smaller image on the negative. Making the photographs

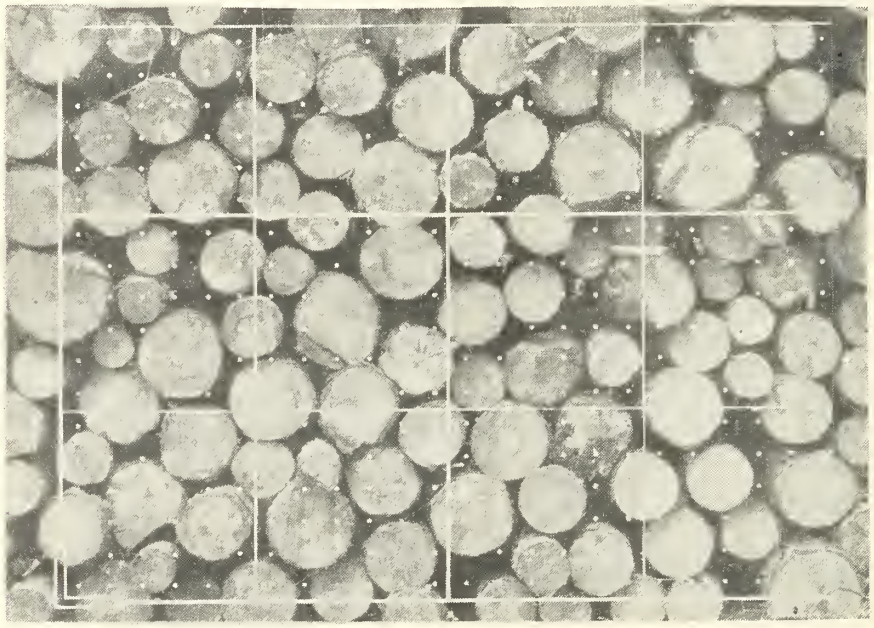

Figure 1.--Pile of red pine sticks 4 to 7 inches in diameter, with dot templet superimposed. In this pile, the solid content is 73.8 percent with bark, 62.2 percent without bark. Solid volume per cord is 94.5 cubic feet with bark, 79.6 cubic feet without bark.

from the same distance, of course, resulted in negatives of identical scale.

All obstructions such as brush, leaves, or snow were removed entirely to give a clear view of the ends of the bolts appearing in the photograph.

A 9 x 12 cm. film-pack camera was used, mounted on a tripod. All exposures were made on fast panchromatic film. A light meter was used to determine length of exposure and to assure standard negative quality. Particular attention was paid to exact focussing to insure the sharpest possible negatives.

A yardstick with clearly defined divisions was included in most of the pictures, giving a permanent scale for use in later diameter measurements, if desired. On some of the piles, black keel was used to record on one or two of the bolts such information as species, date of photo, and location by town.

It was noted that the photographs obtained under shade conditions were better adapted to the subsequent dot count. Those made

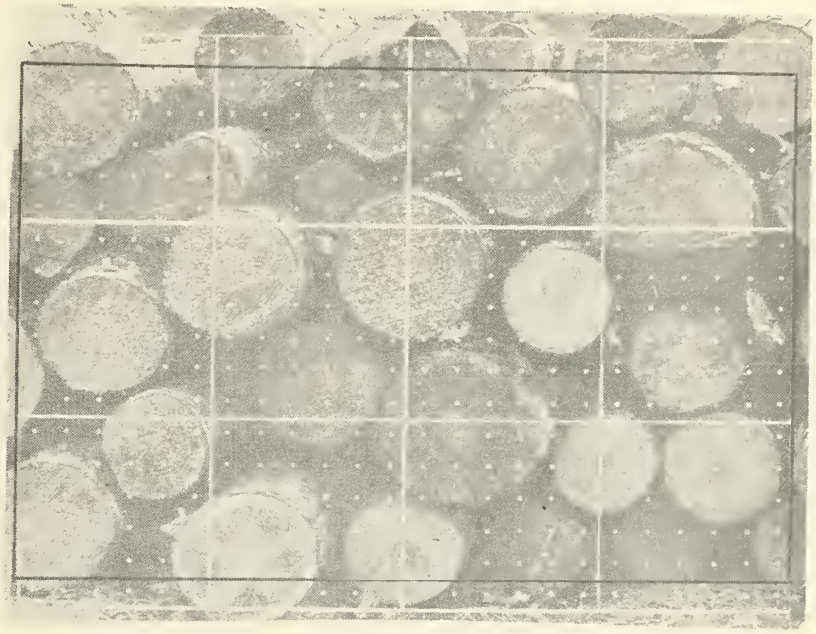

Figure 2.--Red pine sticks 5 to 12 inches in diameter. The wood content of this pile is 70.6 percent with bark, 61.2 percent without bark. Solid volume per cord is 90.4 cubic feet with bark, 78.4 cubic feet without bark. Although the average diameter of this wood is appreciably larger than that in Figure 1, the net solid content is lower because of the rather loose piling.

under bright sunlight were inclined to be too contrasty, although the degree of contrast is under some control in the printing or enlarging process. Light filters were deemed unnecessary; in fact, their use tended to increase the contrast in the photos with some loss of detail in the shadow portions.

Preparation of the Photographs

The finished photographs, ready for the dot count, were produced as follows: a transparent dot templet, 3 by 4 inches, was placed over the photographic paper. In printing, the negative image

was enlarged about 1½ times so that usually the image of the pulpwood sticks was slightly larger than the dimensions of the dot templet. The result was a print of the ends of the bolts with a pattern of white dots on them. The prints were made on glossy paper.

The transparent dot templet used was gridded into 1-inch squares, a total area of 12 square inches; and contained 432 equi-spaced dots approximately 1/40 inch in diameter, with 36 dots per square inch.

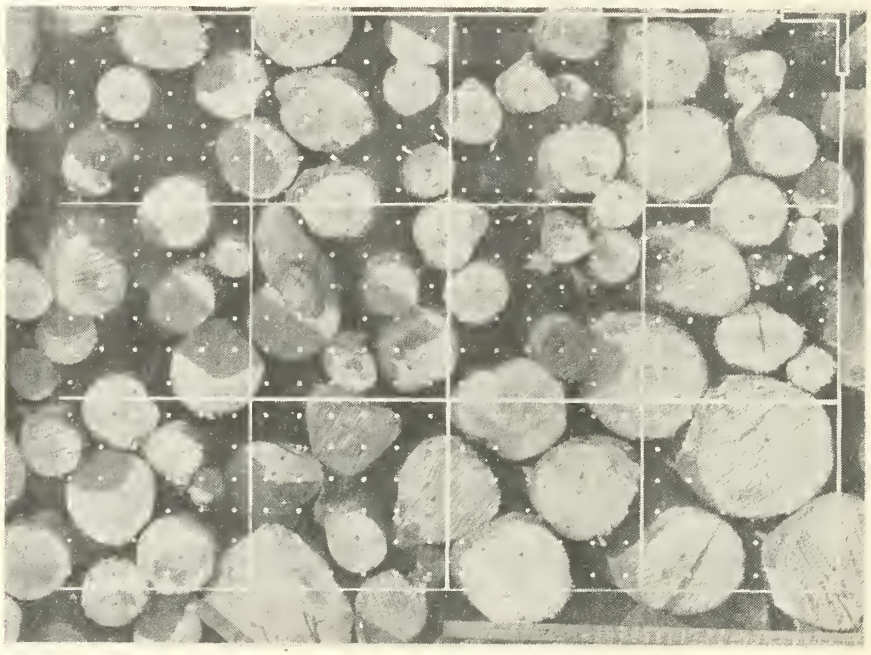

Figure 3.--Mixed hardwoods with 90 percent red maple, sticks 4 to 12 inches in diameter with the majority in the smaller classes. Solid content is 63.2 percent with bark, 53.2 without bark. Solid volume per cord is 81.0 cubic feet with bark, 68.2 cubic feet without bark.

Two enlargements were made from each negative. For the second, the templet was shifted slightly. This gave a total dot count of 864 in most cases for each stack of wood photographed.

Dot Count Procedure

The only aid needed in counting the dots was an inexpensive hand magnifier. Two different counts were made for each photograph, one to determine the solid wood content only, the other to determine wood plus bark content. For ease of counting and to reduce the chance of error, the dots were read from left to right and from top down,

starting at the top left corner. Slightly more than 3 minutes were required to make one dot count of a photograph.

For determining the amount of solid wood only, only those dots that fell on wood were counted. If a dot fell partly on wood, it was counted if more than one-half the dot appeared to be on wood. Borderline dots were alternately considered "in" or "out"; these cases were

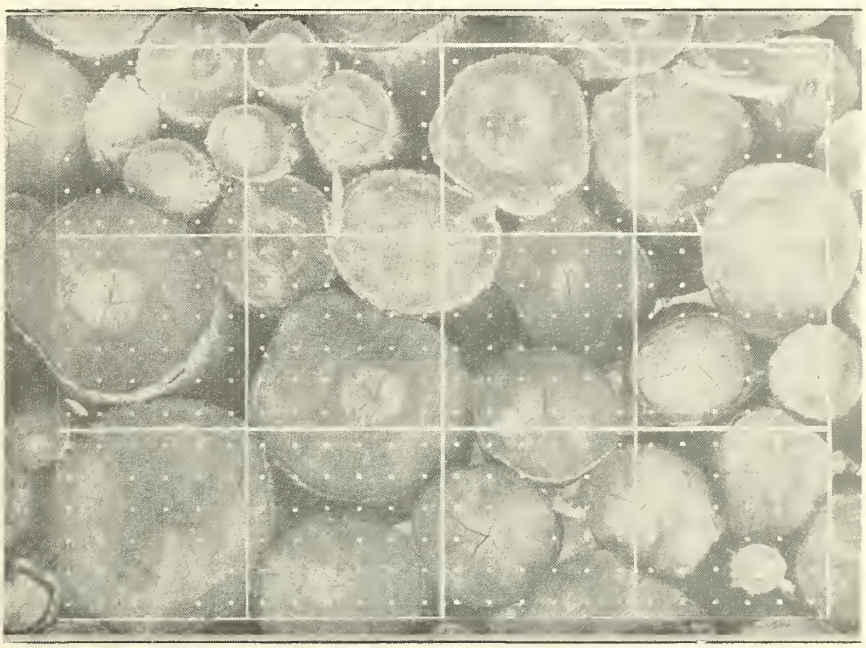

Figure 4.--Mixed hardwoods with oaks predominant, sticks 4 to 12 inches in diameter, the majority in the larger size classes. Solid content 74.3 percent with bark, 68.3 percent without bark. Solid volume per cord 95.1 cubic feet with bark, 87.6 cubic feet without bark.

rare, however, as close inspection with the hand lens generally indicated whether the dot was to be counted. This count, divided by the total number of dots on the sample, provided the ratio of wood to bark and air space.

For determining solid wood plus bark, only those dots were counted that clearly fell neither on the wood nor on the bark; that is, the dots appearing on the air spaces. (The same provision as above was made for borderline cases.) This count--obviously a relatively small figure--subtracted from the total number of dots and divided by the same total, gave the ratio or percent of wood plus bark in the sample.

The percent of bark in the sample, therefore, was the difference

between the percent of solid wood and the percent of solid wood plus bark.

With some of the smaller and lower stacks of wood, a portion of the dot templet fell outside the limits of the stacked wood in the photograph. In these cases the dot count was made only of that rectangular portion of the templet that fell entirely within the area filled by wood.

The accuracy of this method could best be checked by measuring closely the cubic volume of the wood photographed. This could be done by immersing the wood in water and measuring the displacement. It was not possible to do this because of limitations in equipment. However, such a comparison was made in another study[2/] on spruce and fir pulpwood. This study disclosed, in two separate tests involving 10 and $6\frac{1}{4}$ cords respectively, variations between the two methods of only 0.51 and 0.58 cubic feet of wood per cord.

2/ Keepers, C. H. A new method of wood evaluation. Paper Trade Jour. 117 (TAPPI Sect.): 93-97, illus.

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